3DFS
SOFTWARE-DEFINED POWER

Automatically Balancing Phases in AC Electrical Networks

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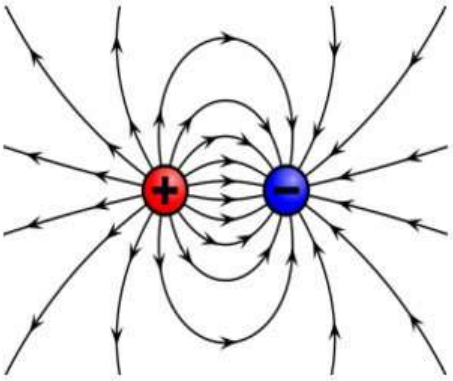
Take a moment to consider how important balance is in electricity. When the balance that is required in the natural order of electricity is thrown off, electric potential energy rapidly becomes kinetic energy. But how sensitive is an electrical environment? How many electrons does it take to throw the balance of an electrical network or grid off?

The power of one electron

To explain the interconnected nature of electricity and how important electrical network balance is, take a look at a single atom.

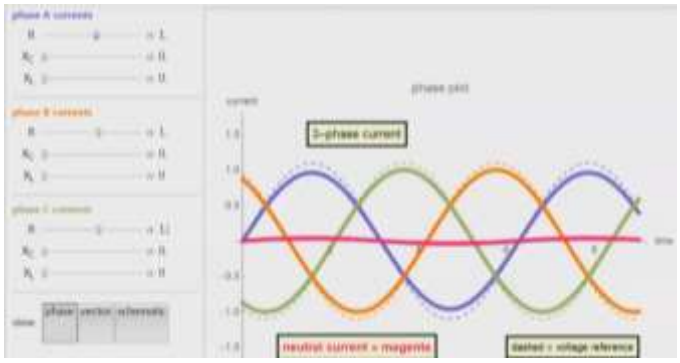


When the number of protons and the electrons are equal, that atom is electrically neutral. But when a single electron is added or removed, that atom is no longer even referred to as an atom anymore, it becomes an ion, either negatively or positively charged.

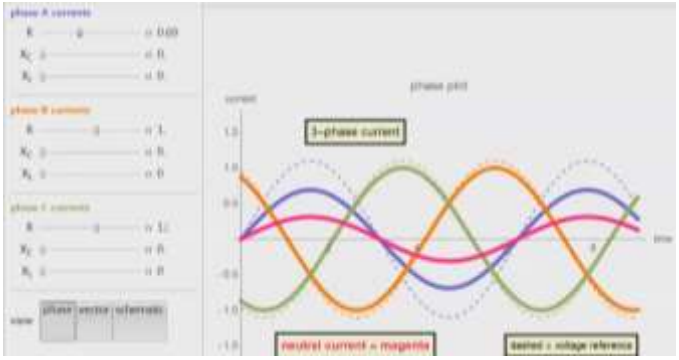
If a single electron imbalance significantly alters the atomic level electric charge, what happens when an innumerable number of electrons furiously interact within our electrical networks and grids?

Neutral Current in Unbalanced AC Electrical Networks

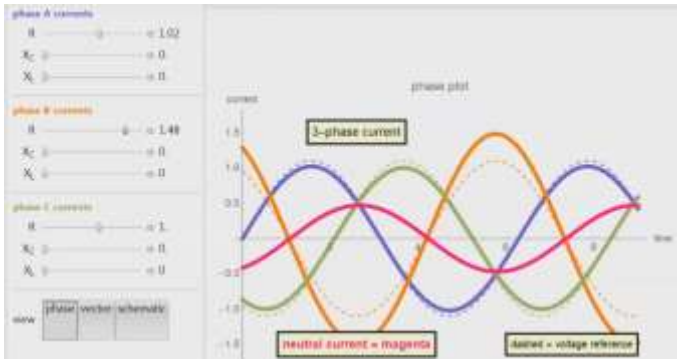
In the United States, electricity travels mainly as AC power, which requires 3 separate live wires and a Neutral wire to transmit and distribute electricity, with an additional wire used for Grounding protection. Each of the live wires is called a phase as it enters our homes and businesses, homes typically have 2 phase power, businesses have 3 phase power.



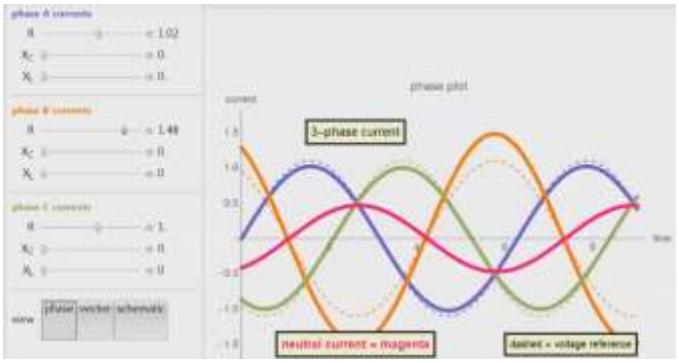
When the Current and Voltage is synchronized and balanced across all phases Neutral Current does not exist.



When a decreased current imbalance is introduced on one phase, the Neutral Current is increased in proportion.



When an increased current imbalance is introduced on one phase, the Neutral Current is still increased in proportion.



When any phase shift (Current leading or lagging the Voltage) is present, a proportional increase in Neutral Current will result.

Humans Balancing AC Electrical Phases

Whether or not the power is 2 or 3 phase, the electricity must be balanced across the phases. If a phase imbalance exists, the basic laws of circuits go into effect and the excess or imbalanced portion of the Current is then returned to the source along the Neutral wire as depicted on the previous sheet. This is dangerous. Neutral wire currents are notorious safety issues and serious fire hazards in addition to reducing the electrical network efficiency, tripping protection devices, and damaging equipment.

For all these reasons, phase imbalance is always considered when working within electrical networks and grids. There are three main ways that we address it today:

Manual Load Shifting, where an electrician opens a breaker panel and physically removes the loads from one phase and inserts them onto another phase. This is usually done after making a matrix of all the loads accounted in the panel in order to determine an appropriate overall panel load Current diversification. Incidentally, the way to check if it worked is maintaining another matrix after the changes have been made, then repeat as necessary until balanced.

Load Scheduling, where the loads in an electrical network are scheduled in a way to turn on and off at precise times to prevent the overloading of any one phase. The starting Current of loads is always more than the operating Current, so this is also done using a matrix and also maintaining a log so that this critical information transfers to the next electrician or energy manager.

Load Shedding, where the loads in an electrical network are immediately turned off in order to instantly "rebalance" the phases. This is usually done by ranking the loads in a network by how long they can be turned off before it affects operations.

All of these methods require extensive human interaction; from the actual replacement of loads, to calculating the matrices that will be used. Perhaps some innovation exists for calculating the matrices, but ultimately, this is a very rudimentary technique for balancing electricity, and this is the methodology used worldwide including in mission critical facilities. This is clearly not a balanced approach. There must be a better way.

The Balanced Way: Software Driven Automatic Phase Balancing

Our methodology for synchronization allows us software control over electricity by using real-time data disaggregation and analysis. With our system, each phase is individually monitored, digitized, and corrected in real time. The high frequency data acquired during correction reveals in astonishing detail precisely what the imbalance is among the phases at the nanosecond timeframe.

Our software monitors the phase imbalance at the nanosecond level and immediately corrects it, simultaneously balancing the phases without human interaction

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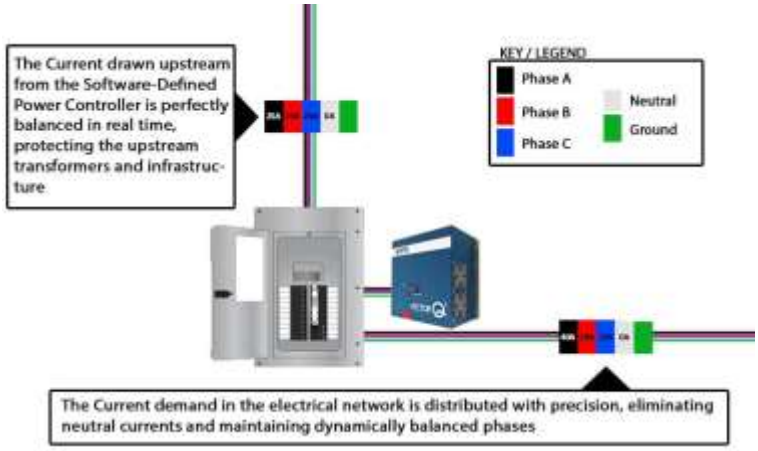
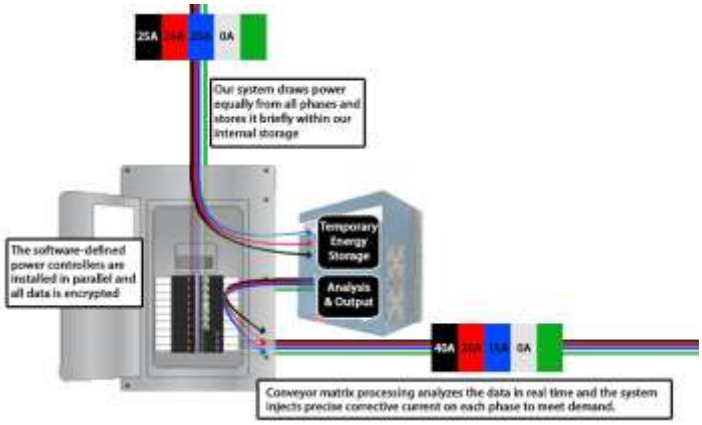
The result of dynamically balanced phases is the elimination of Neutral currents throughout the network. This is an invaluable benefit that comes with our approach to improving electrical efficiency. There are also the added benefits of decreasing liability, providing dynamic stability and increasing the lifetime of all the electrical infrastructure.

Real Time Interaction With Electricity

Our methodology allows for real time data acquisition, analysis, correction, and phase balancing simultaneously. The system is designed to be non-intrusive and perfectly balance the network for a completely optimized electrical environment. This includes the upstream phases and infrastructure along with allowing precision distribution of clean electricity to the entire network.





By automatically balancing the phases in an electrical network with Software-Defined Power, facility electrical networks experience dynamic stability during electrical disturbances. This elasticity prevents the tripping of protections devices and protects all connected loads during power disturbance events. Whether the electrical network is in a facility or in a microgrid, our dynamic solution maximizes uptime and efficiency while decreasing costs and maintenance every microsecond.

Dynamic software controlled management of electricity with full data and verification is essential for any operation. Contact us about protecting your electrical networks with Automatic Phase Balancing and the other innovative features of our Software-Defined Power System.

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